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DESIGN TO COST HANDBOOK

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WARREN H. GILLE, JR.

AUGUST 1988

U.S. ARMY TROOP SUPPORT COMMAND
(TROSCOM)
DIRECTORATE FOR RESOURCE MANAGEMENT
COST ANALYSIS DIVISION
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<p>The Design to Cost Handbook presents an overview of the Design to Cost Program at the U.S. Army Troop Support Command, St. Louis, MO. This program is typical of the Army MSC programs in general.</p> <p>Specific topics covered include - Definition of Design to Cost, Purpose, Application, Participation, Design to Cost Focal Point, Design to Cost Review Boards and Procedures, DTC Waivers and Reports, DTC Regulations and Guidance, AMC Design to Cost Manager, Courses Relating to Design to Cost, Glossary of Terms, Bibliography.</p>					
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Contractor Work Breakdown Structure (CWBS)
Cost
Cost Avoidance
Cost Categories
Cost Element Structure (CES)
Cost Estimating Relationships (CER)
Cost Initiatives
Cost Reduction
Cost Risk
Cost Trend Analysis
Design to Cost Action Plan
Design to Cost Implementation Plan
Design to Cost Status Report
Targets
Tradeoff Studies
Integrated Logistics Support
Cost Tracking
Milestones
Program Sponsor
Operating and Support Cost
Tradeoff Activity
Unit Production Cost

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FOREWORD

This handbook was written to provide a simple and convenient reference for Design to Cost responsibilities, functions, and concepts. It is a summary of salient points selected from Army Regulations, AMC Supplements, and other pertinent documents. It is intended to provide a general introduction to the Design to Cost program and how it operates.

The principal source documents used in developing this publication are listed in Section VII of this handbook.


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CHIEF, Cost Analysis Division

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DESIGN TO COST (DTC) HANDBOOK

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I. Introduction to Design to Cost

A. Definition

Design to Cost (DTC) is a management technique for controlling cost by "designing to specified goals." During the development of a piece of hardware, financial incentives or awards are paid to the developer under design to cost provisions when he meets the contractual goals.

The two components of Design to Cost (DTC) are:

- Design to Unit Production Cost (DTUPC)

This effort uses incentives and/or awards to achieve specified unit production cost goals stated in the contract, through creative engineering and cost control techniques.

- Design to Operating and Support Cost (DTOSC)

This effort uses incentives and/or awards to develop a unit design that will achieve operating and support goals specified in the contract.

B. Purpose

The purpose of Design to Cost is to stimulate creativity in the design of Army materiel in order to control the cost of its production and/or operation. Creativity is stimulated through the use of incentives and awards. Incentives are scheduled payments made when contracted goals are achieved, or when creative contracting is employed e.g., giving production options if goals are achieved. Incentives must be well documented and all pertinent information must be written into the contract. Awards, as opposed to incentives, are payable based on a subjective evaluation of contractor performance in achieving government goals that are readily measurable. Design to Cost treats cost as a key design factor, equal in importance to system design, performance, and schedule.

C. Applicability

Design to Cost in the Army applies to any program which has a total production cost of more than \$40 million. DTC waivers and exemptions may be issued on the basis of national security, performance or schedule priority, and cost effectiveness. Approval for DTC waivers is obtained at the local level for systems with total program of less than \$100 million in production cost. When the program has more than \$100 million in production cost, the authority for approving the waiver will be the approval authority assigned to the program.

D. Participation

Participation in the Design to Cost program is mandatory as specified by Army Regulation 70-64, entitled *Design to Cost*. It is the responsibility of the proponent Project Sponsor, Office, or Directorate to report on those programs which qualify for DTC implementation and to obtain any assistance required from the TROSCOM Design to Cost focal point.

The proponent must apply for a waiver for any program which exceeds the \$40 million production cost Design to Cost threshold. Waivers are never automatic, even in those instances in which the regulation clearly implies one. Requests for waivers must first be forwarded to TROSCOM Design to Cost focal point, Directorate for Resource Management, Cost Analysis Division, AMSTR-CCS, at extension 3133, for review and evaluation.

E. Regulations and Guidance

Documents of primary importance to the Design to Cost effort are:

- | | |
|----------------------------|------------------------|
| 1. DOD Directive 4245.3 | Design to Cost (rev) |
| 2. DOD Mil Std 337 | Design to Cost (draft) |
| 3. DOD Handbook 787 | Design to Cost (draft) |
| 4. AR 70-64 | Design to Cost (rev) |
| 5. AMC Suppl 1 to AR 70-64 | Design to Cost (rev) |
| 6. AMC P 70-19 | AMC Guide-DTC (rev) |
| 7. TROSCOM Suppl 1 to AMC | Design to Cost (draft) |
| Suppl 1 to AR 70-64 | |

Rev means the document is currently under revision

Documents 4, 5, and 7 are regulations or supplements to regulations, and define the subject and attendant responsibilities at various levels of authority. Document 6 is a manual of instruction and a Design to Cost handbook with detailed step by step instruction. It is designed to provide indepth explanation of DTC procedures and serves as a reference book.

Guidance and direction in Design to Cost matters comes from the TROSCOM Design to Cost focal point as well. The DTC focal point is trained in Design to Cost principles at the U.S. Army Logistics Management College (ALMC) and has practical experience in the field. In addition, ne has access to assistance and consultation from the AMC Design to Cost manager.

The Design to Cost focal point, Directorate for Resource Management, Cost Analysis Division is available on a consulting basis. Current extension is 3-3133.

II. Focal Point for Design to Cost

A. Role

The role of the TROSCOM Design to Cost focal point includes four basic functions: point of contact with higher headquarters, consultant, administrator, and coordinator.

B. Functions

The functions performed under each role may be outlined as follows:

1. Point of Contact:

- Receives regulations and guidance from higher headquarters for dissemination.
- Obtains specific guidance and assistance for Project Sponsors and other offices from higher headquarters.

2. Consultant:

- Serves as a consultant to Project Sponsors and other offices for Design to Cost matters.

3. Administrator:

- Serves as local administrator for Design to Cost program.
- Reviews Acquisition Plans for Design to Cost candidates.
- Surveys offices for qualifying DTC programs and assists in application of Design to Cost or obtains waiver.
- Develops and recommends DTC goals for major and non-major systems.
- Represents TROSCOM at special meetings such as Design to Cost Video Conferences.
- Compiles reports such as the Design to Cost Quarterly Status Report for higher headquarters.
- Monitors contract performance and milestone achievement.

4. Coordinator:

- Serves on TROSCOM DTC Board and organizes meetings and activities.
- Coordinates the TROSCOM Design to Cost program.

C. Responsibilities

- Carrying out the provisions of AR 70-64 *Design to Cost* as they are to be applied through the TROSCOM Design to Cost focal point.

- Writing the TROSCOM supplement to AMC Supplement 1 to AR 70-64 and carrying out its provisions.
- Implementing guidance supplied by higher headquarters at the local level.

III. TROSCOM Design to Cost Board

A. Purpose - To review, analyze, validate, and recommend approval/disapproval of Design to Cost packages, when applicable. To review requests for waivers and vote on the above in accordance with the AMC Supplement 1 to AR 70-64, Design to Cost.

B. Organization - The TROSCOM Design to Cost Board consists of Director or Management level representatives from the following offices:

Directorate for Resource Management	Chairman
Directorate for Production and Procurement	Member
Directorate for Integrated Logistics	Member
Directorate for Product Assurance	Member
Directorate for Maintenance	Member
Directorate for Readiness	Member
Research and Development Integration Office	Member
Legal Office	Member
Program/Project Management Office, as applicable	Member
RD&E Center, as applicable	Member
(All of the above are voting participants of the board.)	

C. Duties - The TROSCOM Design to Cost Board has the following general responsibilities.

- Hold quarterly meetings to discuss Design to Cost matters, issues, and guidance.
- Review Design to Cost waiver requests and vote for or against their approval. Ensure those under \$100 million in production cost are approved at the local level.
- Review and analyze Design to Cost packages for inclusion into contracts. Review the progress of previously approved packages.
- Assist Project Sponsors or other offices by providing specialized counsel on DTC matters

D. Waivers and Reports - Several reports are prepared for submission to higher headquarters. Among them are:

- Design to Cost Quarterly Status Report. This report provides information for all new and existing programs and projects. It tracks DTC goals and targets for development projects. Forms and formats for completing this report are discussed in AR 70-64. This will soon be an automated on line system.

- Design to Cost Waivers. These waivers are to be forwarded to the Design to Cost Manager, HQ AMC, for review and/or approval.

IV. AMC Design to Cost Manager.

This person is the AMC Manager who is responsible for overseeing the Design to Cost activities at the various major subordinate commands and other MACOMs. In addition to writing, reviewing, and approving documents such as the AR and waiver requests, he also serves as a problem solver providing guidance and assistance to the focal points at the MSCs and other Major Commands.

Currently, the AMC Design to Cost Manager is Mr. John P. Rosso, Jr. He works for COL William Murry, Chief, Acquisition Policy Division, DCS for Development, Engineering and Acquisition - Acquisition Management, HQ AMC.

V. Courses Relating to Design to Cost

Design to Cost Course (ALMC-CF), U.S. Army Logistics Management College, one week in length, and usually offered quarterly.

Purpose: To provide an understanding of the concepts, management, implementation requirements, and technical aspects of the Design to Cost (DTC) Program within the Department of the Army.

Scope: This course will provide a broad spectrum of knowledge pertaining to the Design to Cost Program. It covers DOD and Army policy, methods of implementation and the technical aspects of contracting and cost analysis applicable to the program.

Prerequisites: Nominees should be assigned to a DTC related position in a program/project management or cost analysis office or other organization which deals directly or indirectly with DTC requirements.

Military Personnel: Commissioned officers, Senior non-commissioned officers. Waivers may be granted.

Civilian Personnel: Career or career conditional personnel, GS-07 or above, waivers may be granted.

VI. Glossary of Terms (adopted from AMC-P 70-19 and other sources)

1. *Baseline Cost Estimate (BCE)*. Detailed estimate of acquisition and ownership costs normally required for high-level decisions; provides the basis for subsequent tracking and auditing.

2. **Contractor Work Breakdown Structure (CWBS).** The complete WBS covering a particular contractor procurement. The CWBS is a breakdown and identification, for a particular procurement, of all of the acquisition tasks required during the development and production of a system or other equipment. The CWBS closely follows the guidelines of MIL-STD-881A and DODI 5000.33 in identifying the hardware, services, and data required by a particular program or project throughout its planned life cycle. Many of the elements of the CWBS can be found in the Cost Estimate Structure (CES), and are closely related to the WBS of the major equipment.
3. **Cost.** In this document, cost is defined as Life Cycle Cost (LCC) or a portion thereof.
4. **Cost Avoidance.** Cost reductions that are reasonably measurable through the cost reduction program. They are reductions that prevent increases in cost or requirements for funds or have produced an increase in readiness at no additional cost. Cost effective design choices based on timely, concise (tailored for each user) cost information.
5. **Cost Categories.** The major divisions of weapon/support system costs which apply to DTC from inception to retirement of the system. These are:
- a. **Research and Development:** All RDT&E funded costs associated with the development of the materiel system, including development costs for system armament, training devices, ammunition, missiles and modifications.
 - b. **Production:** The term Production Cost is defined to be the sum of those procurement appropriation funded costs resulting from the production and introduction of the materiel system into the Army's operational inventory. This includes:
 - All costs to the Government, defined as contractor costs plus in-house costs, of products and services necessary to transform the results of development into a fully operational system consisting of the hardware, training, and support activities necessary to initiate operations.
 - Costs of both a nonrecurring nature, i.e., costs which are required to establish a production capability, and a recurring nature, i.e., costs which occur repeatedly during production and delivery to user organizations.
 - All costs resulting from production and introduction into inventory irrespective of how allocated, e.g., Unit Equipment (UE), Maintenance Float (MF) and Training Usage classification.

- c. **Deployment:** The continuing recurring process of operating and maintaining force structure and materiel systems to perform assigned tests and missions. The level of sustainment is a function of force allocation and training objectives, as well as the operating tempo assigned to individual materiel systems. Deployment generally begins when the materiel system is fielded and ends when the materiel system is disposed of.
6. **Cost Element Structure (CES).** A breakdown of life cycle cost elements that can be summarized under the major cost categories of research and development, production and sustainment. Each major cost category is further broken down into a hierarchy of lower level cost elements. Each of the Military Services uses a total CES which is very similar among the major subelements but does differ in the arrangement of definitions of lower level cost elements. In addition, each Service can present a simplified CES as a contractual requirement for a contractor's work. A CES may be different for each phase of the life cycle, but must be consistent with the Work Breakdown Structure (WBS). For these reasons, this document does not include any standardized CES.
7. **Cost Estimating Relationship (CER).** A mathematical expression relating cost as the dependent variable, to one or more independent cost-driving variables. The expression may be represented by any of several functions (e.g., linear, power, exponential, hyperbolic). These cost-driving variables usually represent characteristics of system/product performance, physical features, effectiveness factors, or even other cost elements.
8. **Cost Initiatives.** A cost initiative must be identified by the cost trend analysis. Each initiative must include background, action taken to date, action planned, and the current assessment at successful completion. Periodic progress on efforts to rectify a cost threshold breach as identified in a DTC Action Plan, should be reported immediately.
9. **Cost Reduction.** Formal activity employed to reduce cost. A cost reduction effort has a specified quantitative target, and a threshold somewhat higher or lower as the case may be.
10. **Cost Risk.** A qualitative assessment of the chances of failing to achieve a design which is (a) affordable to procure, operate, and support; and (b) acceptable in terms of performance, readiness, supportability, and schedule. Cost risk is directly proportional to technical risk and estimating uncertainty.

11. ***Design to Cost (DTC).*** An acquisition management technique used to achieve defense system designs that meet stated cost requirements. Cost is addressed on a continuing basis as part of a system's development and production process. The technique embodies early establishment of realistic but rigorous cost objectives, goals and thresholds, and a determined effort to achieve them. DTC is a concept that established cost elements as management goals to achieve the best balance between life cycle cost, acceptable performance, and schedules. With this concept, cost is a design constraint during the design and development phases and a management discipline throughout the acquisition and operation of the system of equipment. DTC is a cost control technique developed to achieve defense system designs that meet stated cost requirements. Cost is addressed on a continuing basis as a part of a system's design process.
12. ***Cost Trend Analysis.*** The evaluation of cost tracking information to identify adverse trends in terms of Life Cycle Cost (LCC), cost targets, and/or the individual allocated cost subtargets. Identified problem areas shall be analyzed for interim action. When implemented these interim actions become cost initiatives.
13. ***DTC Action Plan.*** A part of the DTC implementation plan applies when cost targets are about to be or have been breached. As a revision to the DTC Plan, the contractor shall prepare and submit a DTC Action Plan for each instance where the projected cost of the current design is above a cost threshold. This plan shall identify the specific effort necessary to control costs and to get the projected cost back to an acceptable level. This cost reduction effort shall be discussed in terms of the cost to implement, schedule, risk, and benefits.
14. ***DTC Implementation Plan.*** This plan is a document which provides the integrated program plan for the time-phased activities required to accomplish a specific set of DTC objectives. It is a dynamic document subject to revision and change as the system evolves. The purchasing activity approves the initial plan which was required by the contract. The contractor shall be required, either before (in his proposal) or after contract award, to submit the DTC implementation plan which may include recommendations for changes to the Government's. This plan describes the key elements required for implementing a DTC program.
15. ***DTC Objectives.*** Tentative values subject to revision and tradeoff until DTC goals and thresholds are established.

16. **DTC Parameter.** Approved measurable values for selected cost elements established during system development as design considerations and management objectives for subsequent life cycle phase. A DTC parameter may be an objective, goals, or threshold. Values will be expressed in constant dollars, resources required, as other measurable factors that influence cost.
17. **DTC Plan.** The information generated by the contractor's DTC program planning effort shall be summarized in the form of a DTC Plan and submitted in accordance with the DD Form 1423. The DTC Plan shall be sufficiently comprehensive to enable the procuring activity to: (1) ascertain with a high degree of confidence that the contractor has adequately evaluated and planned for an active engineering cost control effort; and (2) monitor the contractual effort to ensure timely and effective execution of the DTC program. This plan shall also (in appendix B of DOD DTC MIL STD) provide for an action plan which will be submitted whenever a potential breach of a cost threshold is imminent.
18. **DTC Status Report.** In accordance with the DD Form 1423, the contractor shall periodically (usually quarterly) report progress in meeting the cost targets or, if targets have not yet been established, report the status of the present estimates compared to the baseline estimates until the DTC Status Report is automated in late 1988. Electronic mail should be considered as a timely means of submitting the DTC Status Report for programs where the risk of meeting cost targets is high. The final periodic report shall contain, with supporting rationale, the contractor's proposed cost targets for the next phase.
19. **DTC Targets.** Approved DTC parameters divided into smaller, identifiable tasks or areas of responsibilities that serve as requisites for contractors or Government activities. Cost estimates approved by the purchasing activity which are translated into design requirements by the contractor for the purpose of controlling and balancing production and O&S costs. A cost target is different from a cost baseline in that a contractual target is a reference point for measuring cost growth. For effective management, cost targets are usually subdivided and allocated as subtargets to the responsible managers and designers. Contractual cost targets should be maintained as rigorous and realistic to sustain a viable DTC program.

20. ***DTC Tradeoff Studies.*** The tradeoffs should be developed as necessary to address major cost drivers not covered in other formal engineering tradeoff studies. These studies should include a discussion of the schedule, level of efforts, and means and depth of detail of reporting the results. These studies should be updated as new tradeoffs are developed and as the results of the trade studies are completed. A rewrite of the plan is not necessary for these updates; for example, ("change 1 to Trade Study Section follows:").
21. ***Integrated Logistics Support (ILS).*** A disciplined, unified, and interactive approach to the management and technical activities necessary to (a) integrate support considerations into system and equipment design; (b) develop support requirements that are related consistently to readiness objectives to design and to each other; (c) acquire the required support; and (d) provide the required support during the operational phase at minimum cost.
22. ***Integrated Logistics Support Plan (ILSP).*** A document which provides a comprehensive and detailed plan for implementing concepts, techniques, and policies necessary to achieve the ILS objectives of assuring the effective and economical support of a system or equipment for its life cycle. The program sponsor shall develop an ILS plan by Milestone 1 and keep it current throughout acquisition. The ILS Plan shall integrate logistics aspects of the program. Positive controls shall be established to integrate schedules and to identify interdependencies among ILS elements, design activities, and deployment plans. The ILS Plan shall document readiness and support objectives, achievements to be demonstrated, operating concepts, deployment requirements (including transportability), support concepts, plans, ILS element requirements, schedule, funding requirements, and responsibilities for ILS activity planned for each program phase. For multi-DOD component program, the ILS Plan shall address the support requirements for all participating DOD components. The program manager shall furnish contractors with appropriate Government data such as baseline operating scenario and maintenance concepts, such as baseline operating scenario and maintenance concepts, systems readiness objectives, and support costs on current systems to use as a basis for contractor ILS planning and analysis. The program sponsor shall maintain current ILS management information (including detail of schedule, resource requirement and funding, LSA documentation, and status of progress toward support related thresholds) to support ILS planning and management decisions.

23. **Life Cycle Cost (LCC).** Includes all WBS elements; all related appropriations; and encompasses the costs, both contract and in-house for all cost categories. It is the total cost to the Government for a system over its full life and it includes the cost of development, procurement, operating and support, and where applicable, disposal. For DTC tracking purposes, the contractor should consider only those elements of LCC which can be influenced by the contractor's design process.
24. **LCC and Goal Tracking.** A comparison of the current status versus target, and current status versus the previously reported status. For LCC this comparison shall be the current LCC estimate versus the baseline LCC estimate and previous LCC estimate to illustrate LCC trends. For cost targets this comparison shall be in terms of total targets and any allocated subtargets. Whenever the cost targets or the baseline LCC estimate is changed to include an explanation and a quantitative substantiation for the change.
25. **Logistics Support Analysis (LSA).** The selective application of scientific and engineering process, to assist in: (a) causing support considerations to influence design; (b) defining support requirements that are related to design and to each other; (c) acquiring the required support; and (d) providing the required support during the operational phase at minimum cost.
26. **Milestones.** A schedule for reviewing the status and effectiveness of the DTC program. Formal DTC reviews shall be held periodically between the procuring activity and contractor DTC personnel. Care should be taken in spacing these reviews to ensure that enough new design information is available to warrant the expense of preparing and attending these reviews. Additionally, all formal project status reviews, preliminary design reviews, and critical design reviews shall include a review of the DTC program and an assessment of its effectiveness in controlling cost. These reviews provide the best opportunity for the Government to ensure the continued effectiveness of the contractor's engineering cost control effort.
27. **Program Sponsor.** A generic term which encompasses Program Manager, Project Manager, Product Manager, and Item Manager. Program Manager is specifically reserved for major program managers.

28. *Operating and Support (O&S) DTC Parameters.* Approved values for selected O&S elements expressed either in dollars or by other measurable factors, such as number of maintenance personnel, spares, fuel and other resource consumption, reliability, and maintainability. Design to Cost efforts that focus on O&S costs of parameters (e.g., mean-time-between-failures, maintenance hours per flying hour, mean-time-to-repair, etc.) are sometimes referred to as Design to O&S Costs (DTOSC) (Army).
29. *Organization.* Organization for the DTC function does not imply new organizational entities. For many companies with prior military contracting experience, the functions contributing to the normal cost tracking effort are already in place (e.g., systems engineering, logistics, production planning, reliability, cost analysis and estimating, etc.). The contractor's organization structure will be determined by the contractor's ability for executing the cost control strategy in an effective and efficient manner. It will also include: the management structure; contractor decision authority and approval authority; policies and procedures; and functional relationships for making cost a key decision and design parameter. Additionally, this includes discussion of the functional responsibilities, analytical techniques, and data processing capability for providing current, concise, and timely cost feedback to the organization's decisionmakers. Justify organizational elements which are uniquely DTC-related. If value engineering is contributing to cost reductions, show how it relates to the DTC effort.
30. *Supporting Rationale.* Supporting rationale for the DTC and LCC baseline shall include all guidelines, assumptions, and ground rules. Data sources and cost prediction methodology shall be described in terms of applicability to the stage of design maturity and the state-of-the-art. Alternate approaches or sources considered for the analysis or used for cross-checking purposes, and the associated risk or uncertainty shall also be described in exact terms. Cost estimating expressions for each cost element shall be included with a definition of variables and a substantiation of corresponding values. For proprietary techniques where the contractor will not divulge the cost estimating expression or for cases where the procuring activity has prescribed a cost mode, include only the input data necessary to reproduce the analysis plus the supporting rationale. For cost drivers, summarize the sensitivity analysis or other techniques used to identify them.

31. **Tradeoff Activity.** Consists of formal tradeoff study activities (including any DTC tradeoff studies) and any significant informal tradeoff activities occurring or completed since the previous reporting period. When the DTC recommended alternative in formal trade studies or the low cost affordable option in informal tradeoffs is not selected, include an explanation of why the cost-preferred alternative was not adopted.
32. **Unit Production Cost (UPC).** A cost established prior to the development of an item to guide design and to control program costs. It is the cost to the Government to acquire a production item based on a stated level of production. Unit production cost should only contain those elements under the contractor's control. It is established early in the development to ensure from the start that engineers design and develop an item that will not cost more than the service can afford to pay for the item. A design to cost effort that focuses on UPC is termed Design to Unit Production Cost (DTUPC).

VII. Bibliography

The regulations and documents governing Design to Cost (DTC) include the following:

<i>Publication</i>	<i>Title</i>
AR 70-64	Design to Cost
AR 11-18	The Cost Analysis Program
AMC Suppl 1 to AR 70-64	Design to Cost
AMC Pam 70-19	AMC Design to Cost Guide
TROSCOM Suppl 1 to AMC Suppl 1 to AR 70-64	Design to Cost (DRAFT)
DOD Mil Std 337	Design to Cost (DRAFT)
DODI 5000.1	Major and Non-Major Defense Programs Acquisitions
DODI 5000.2	Defense Acquisition Program Procedures
DODD 4245.3	Design to Cost
DOD-HDBK-787	DOD DTC Handbook (DRAFT)
DODI 5000.33	Uniform Budget/Cost Terms and Definitions